



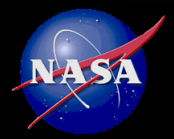
NASA Langley Research Center *Sustainability Case Study*



**NASA Facilities Engineering and Real Property Conference
May 10, 2011 – Nashville, TN**



**NASA Langley Research Center
Hampton, Virginia**



Why Sustainability?



Agenda

- NASA's Sustainability Policy
- “Slow and Steady” Revitalization Program
- NASA Langley Mission
- Historical Perspectives
- LaRC Facility Challenges
- Proactive Approach to Challenges
- New Town
 - Original concept / current concept
 - New Town Phase I
 - New Town Phase II
 - New Town Phase III
 - Summary of NT benefits

Agenda (cont.)

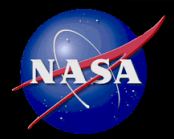
- UESC
- Server Virtualization
- Greening Fleet Operations
- Expanding Bicycle Use
- Renewable Steam Generation
- Recycling Program
- Environmental Restoration Program
- Other Sustainability Considerations
- What's Next?
- Summary



NASA's Sustainability Policy*

- Execute mission without compromising planet's resources so future generations can meet their needs
- Take action now to provide future where the environment and living conditions are protected and enhanced
- Manage risks to mission, environment, and our communities
- To these ends, NASA seeks to:
 - Use public funds efficiently and effectively
 - Promote the health of the planet
 - Operate in a way that benefits our neighbors.

* NASA 2010 Strategic Sustainability Performance Plan



Sustainability Policy Implementation

- Increase energy efficiency and use of renewable energy
- Reduce greenhouse gas emissions
- Conserve/protect water resources
- Eliminate waste, recycle, prevent pollution
- Leverage acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products, and services
- Design, construct, maintain, and operate high performance sustainable buildings
- Strengthen the vitality and livability of the communities that surround NASA Centers and facilities



Sustainability Policy Goals



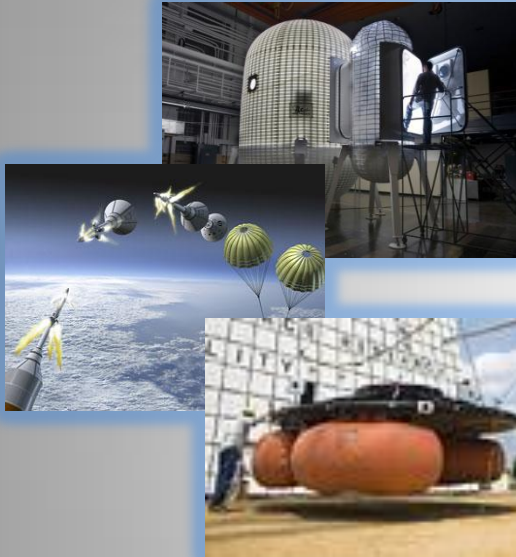
- Scope 1 & 2 Greenhouse Gas Reduction
- Scope 3 Greenhouse Gas Reduction & Develop and Maintain Agency Comprehensive Greenhouse Gas Inventory
- High-Performance Sustainable Design / Green Buildings & Regional and Local Planning
- Water Use Efficiency and Management
- Pollution Prevention and Waste Reduction
- Sustainable Acquisition
- Electronic Stewardship and Data Centers
- Agency Innovation & Government-Wide Support



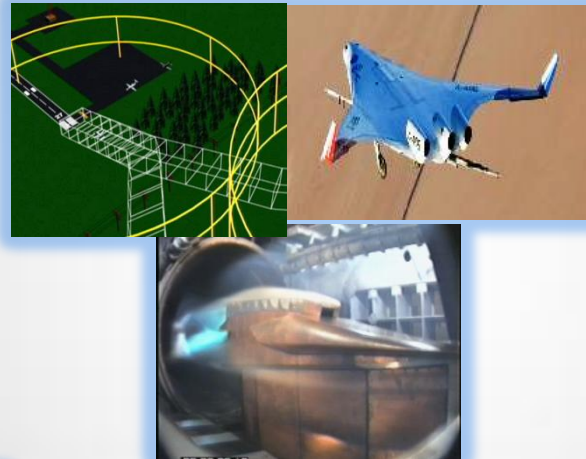
“Slow and Steady” Revitalization Program

- **Rehabilitate** facilities when cost effective
- **Repair-by-Replacement** when rehabilitation of facilities is not cost effective
- Fund **Operations/Maintenance to cover (mission) critical facilities** and highest priority requirements
- **Demolish and/or deconstruct** facilities that are no longer required
- Smartly **shut down** and **mothball** facilities if they are not needed

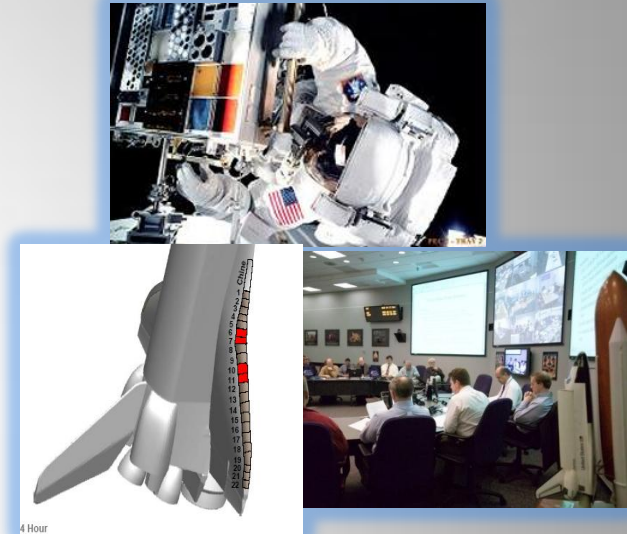
NASA Langley Mission



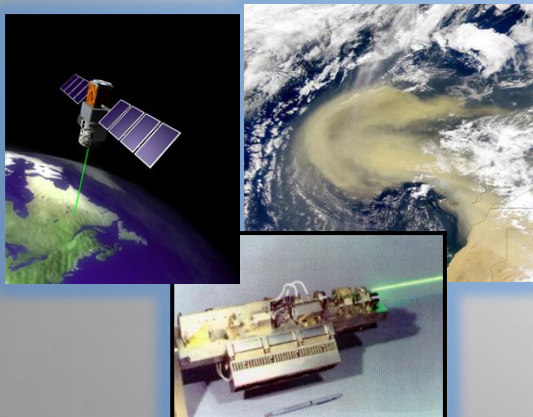
EXPLORATION



AERONAUTICS



SPACE OPERATIONS



SCIENCE



CROSS-AGENCY SUPPORT

Historical Perspectives





Full Scale (Building 643)





Full Scale (Building 643)





LANGLEY
SPEEDWAY
THE FASTEST RACE TRACK

NASCAR
NIGHT OF CHAMPIONS
OCT 16 7PM
LANGLEY SPEEDWAY.COM
BUS RACE

RICKY WID
7PM



04/12/2011 09:10

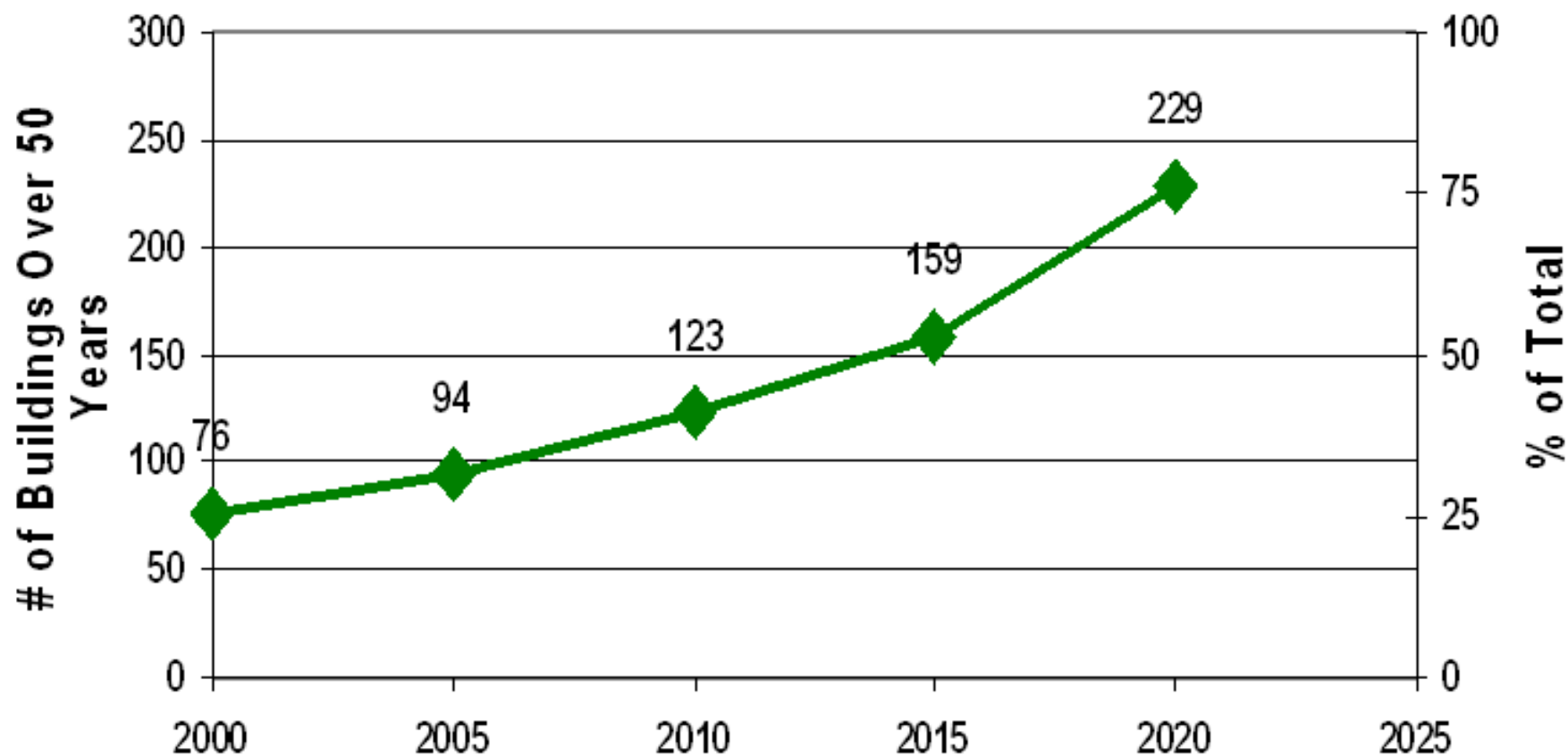


16' (Building 1146)



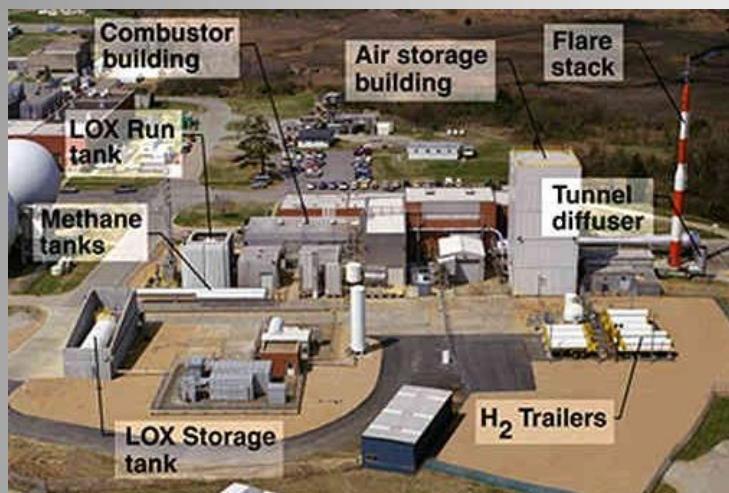
Langley Facility Challenges

LaRC's Building Age



Sustaining Aging Facilities: Currently LaRC has approximately 110 buildings over 50 years old, a number that will nearly double in the next decade, unless a revitalization program is implemented.

Additional Challenges



Maintaining High-Energy Systems

- High pressure air and steam
- High voltage power distribution

Preparing for Future Agency Needs

- Upgrade / Enhance existing facilities or build new
- Gantry:
 - Built for Apollo program (lunar landing training)
 - Converted for Aero use (full-scale crash testing)
 - Converted for Exploration use (landing tests in support of ascent abort)
 - Expanding use with Hydro Impact Basin

Providing Appropriate Work Environments

- Reliable infrastructure
- ADA compliance
- Office and lab space requirements
- Teaming
- Morale





Proactive Approach to Challenges

- Office Space Consolidation
 - 228,000 sq. feet vacated
- Closures
 - 135 facilities closed
- Demolition
 - 80 facilities demolished
- Total Cost Avoidance
 - \$2.9M per year
- Reimbursable Interagency Agreements
 - Leased used office space to Air Force through FY11
- Lab Consolidation
 - 15 lab facilities affected

Significant savings, but still not enough!

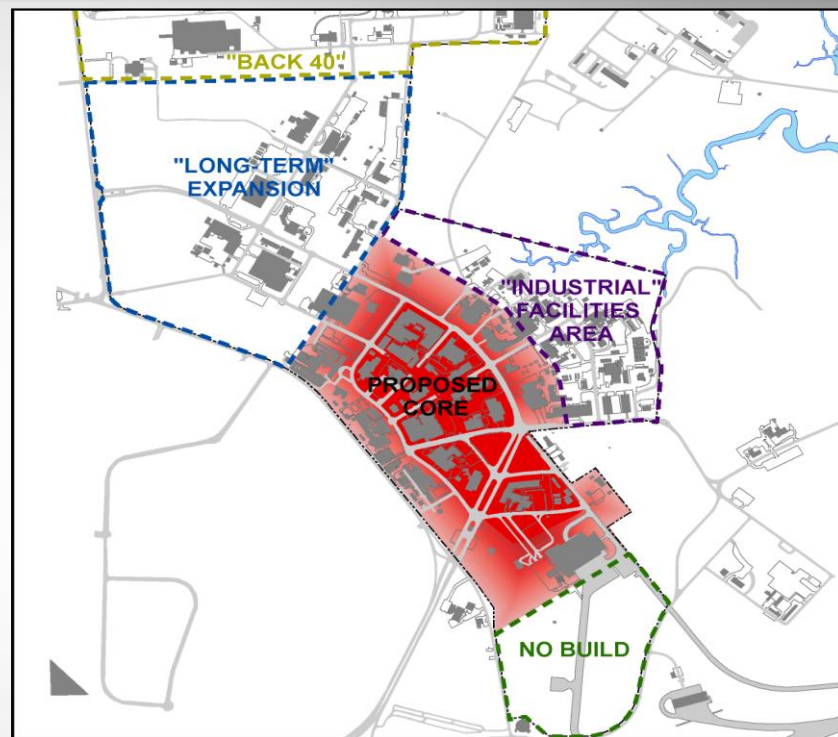


Major Repair-by-Replacement Effort is Critical to Langley's Future – *New Town*



Benefits

- Drastically reduce energy consumption
- Improves Facility Condition Index
- Reduces Operating and Maintenance Costs
- Reduces Deferred Maintenance
- Reduces Facilities Footprint
- Fosters Collaboration
- Improves Flexibility
- Strengthens Langley's Capabilities



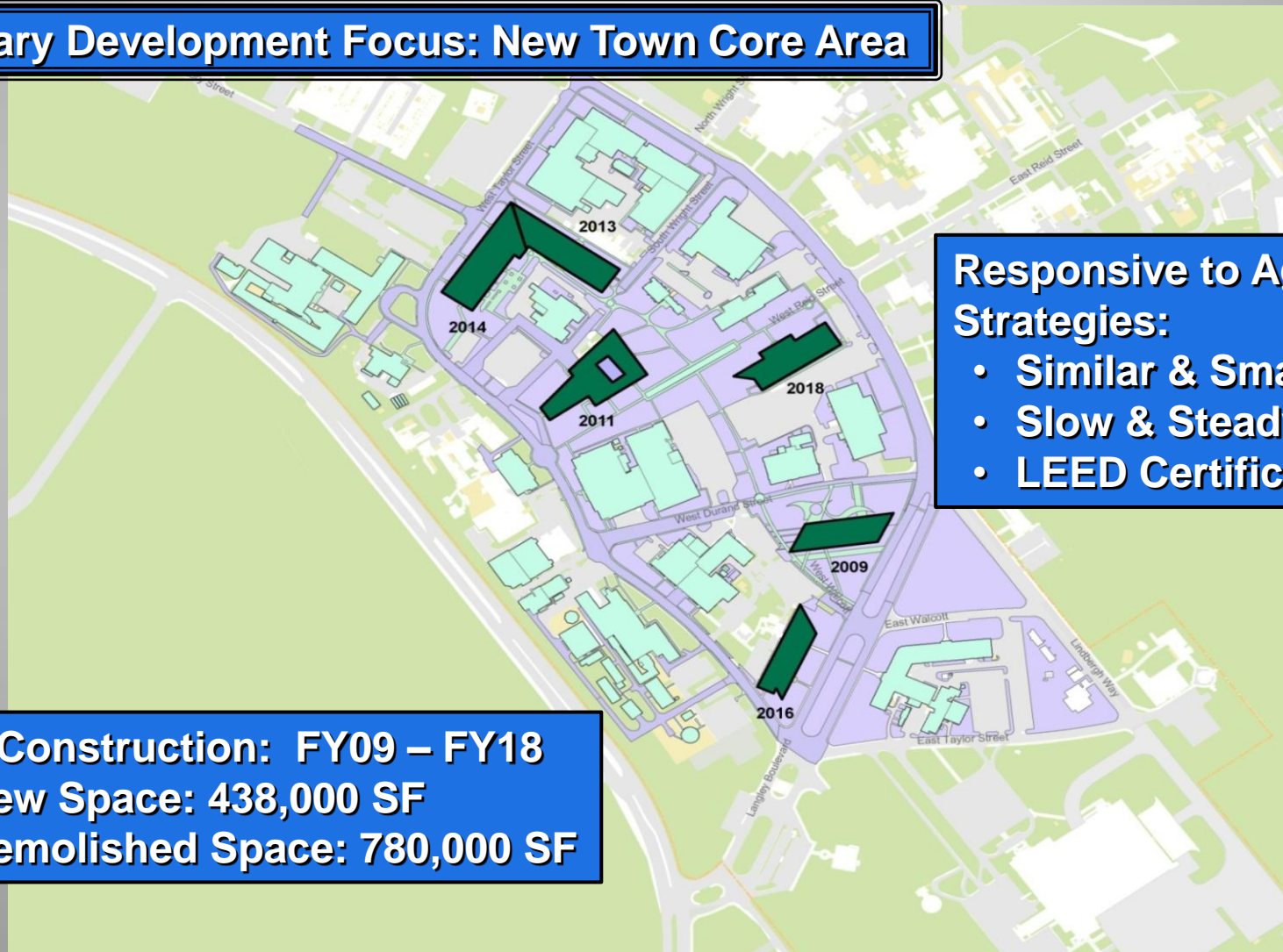
Original New Town Concept (2003)



- Strengthen the Langley Campus**
- Development in “Core Area”
 - Impact on Entire Campus

New Town Campus Concept

Primary Development Focus: New Town Core Area



Responsive to Agency Strategies:

- Similar & Smaller
- Slow & Steady
- LEED Certification

New Construction: FY09 – FY18

- New Space: 438,000 SF
- Demolished Space: 780,000 SF



Phase 1 Building Site Plan



Credit
Union

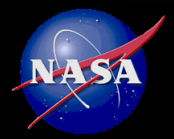
Phase 1 Design

Phase 1 Administrative Office Building (AOB1)

- 74,000 GSF, three floors
- Six organizations, 260 occupants
- Designed to achieve LEED Gold certification



Architectural illustration looking from center of campus



New Town AOB1: NASA Langley Headquarters

Sustainability Goals:

- ☐ Community and collaboration
- ☐ Operational flexibility
- ☐ Daylight and views
- ☐ Fresh air
- ☐ Healthy materials
- ☐ Environmentally “friendly”



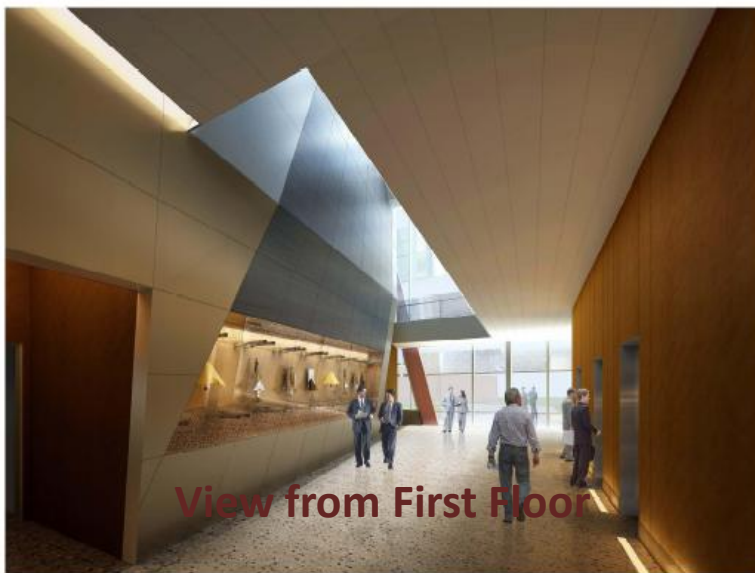


Phase 1 Building Site Plan LEED Considerations

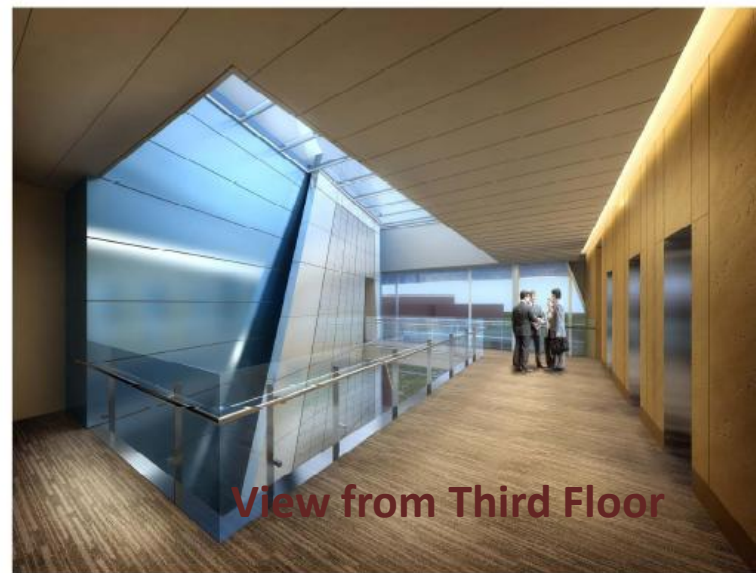




Phase 1 Building Internal View of Lobby Area



View at Level 1 - To South



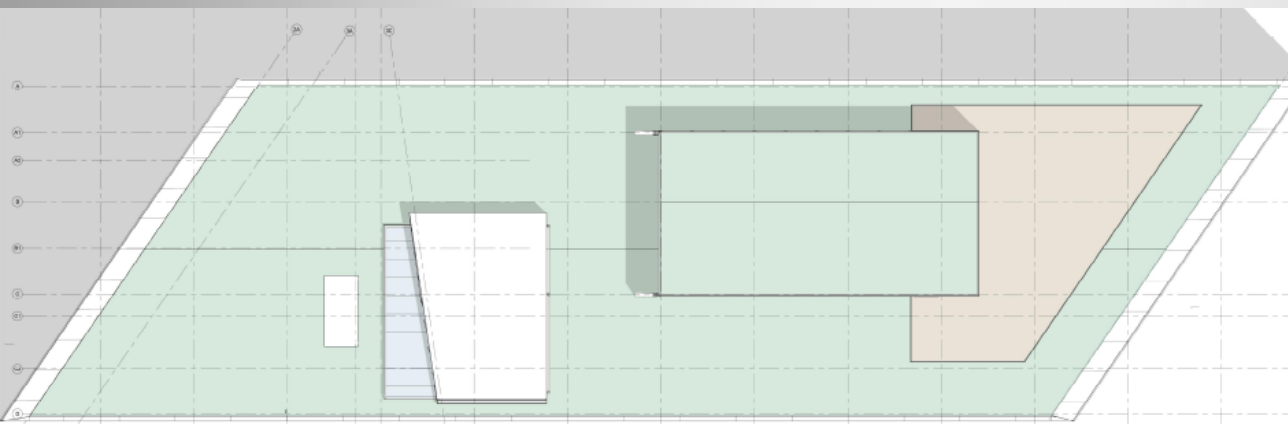
View at Level 3 - To South



New Town Green Enhancements

Green Roof:

- Reduces Heat Island Effect
- Reduces Heating and A/C Cost
- Extends Lifetime of Roof
- Absorbs 15%-90% of Storm Water
- Reduces Noise Transfer
- Improves Rooftop View



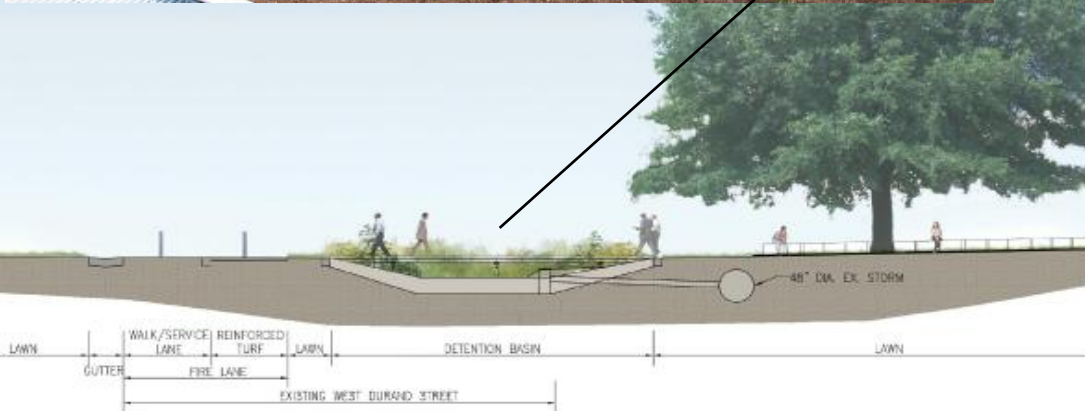


New Town Green Enhancements



Water Retention Area:

- Reduces Storm Water Runoff
- Environmentally Friendly

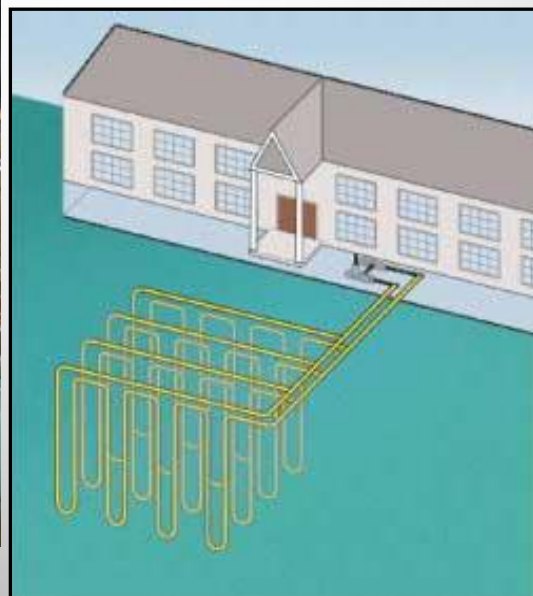
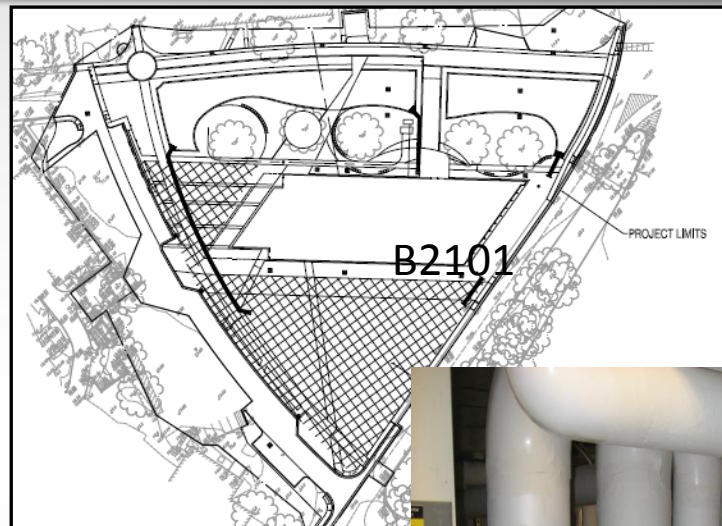




New Town Green Enhancements

Geothermal Ground Source Heating/Cooling System:

- Saves 25% to 50% HVAC energy
- Reduces Heating and A/C Cost
- Uses Renewable Energy
- Is a Low Maintenance System
- 90 wells, 350' to 400' deep





New Town Green Enhancements

❑ Pervious Pavements:

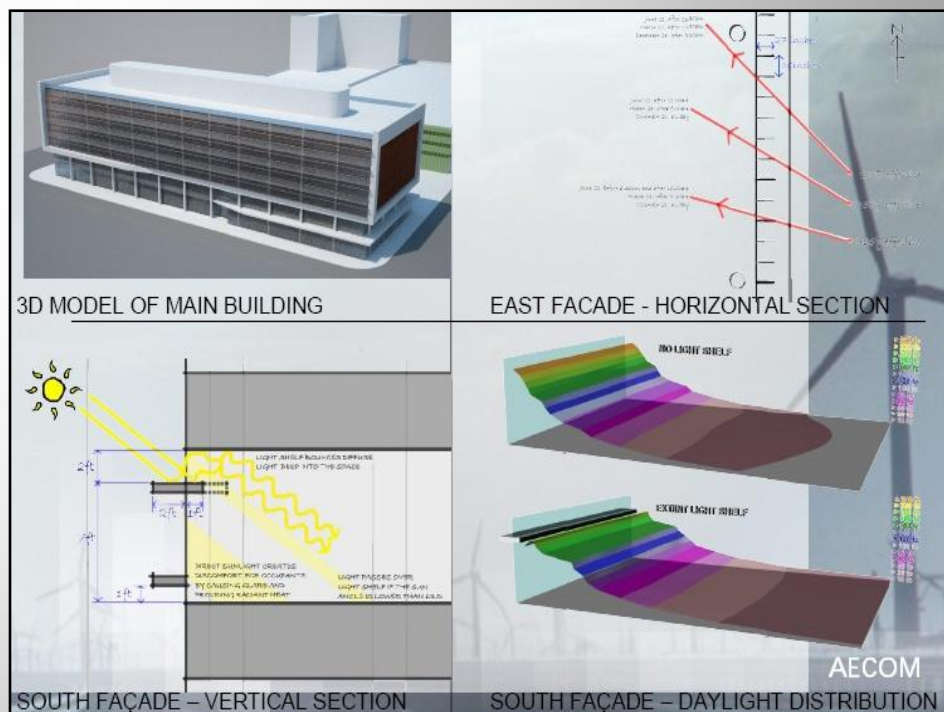
- Reduces Storm Water Runoff
- Coverage: 40% of project hardscape



New Town Green Enhancements

□ Optimization of Daylighting Strategy

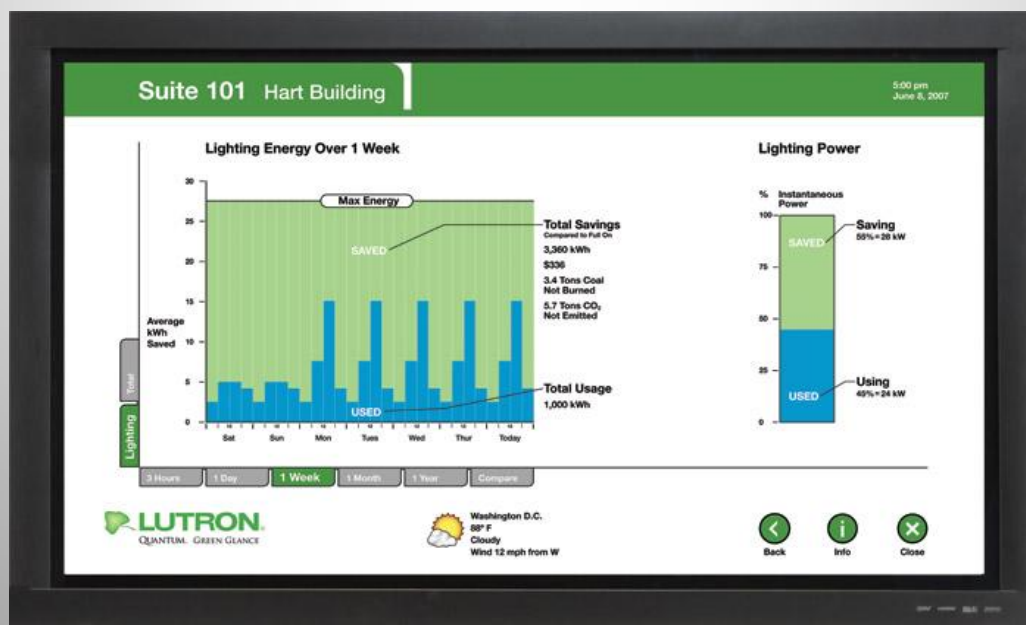
- Max Use of Natural Lighting
- Uses Shading Devices and Light Shelves
- Uses Shallow Building Depth and Max Ceiling Height
- Uses Strategic Building Orientation
- Uses Solar Sensors on Lights



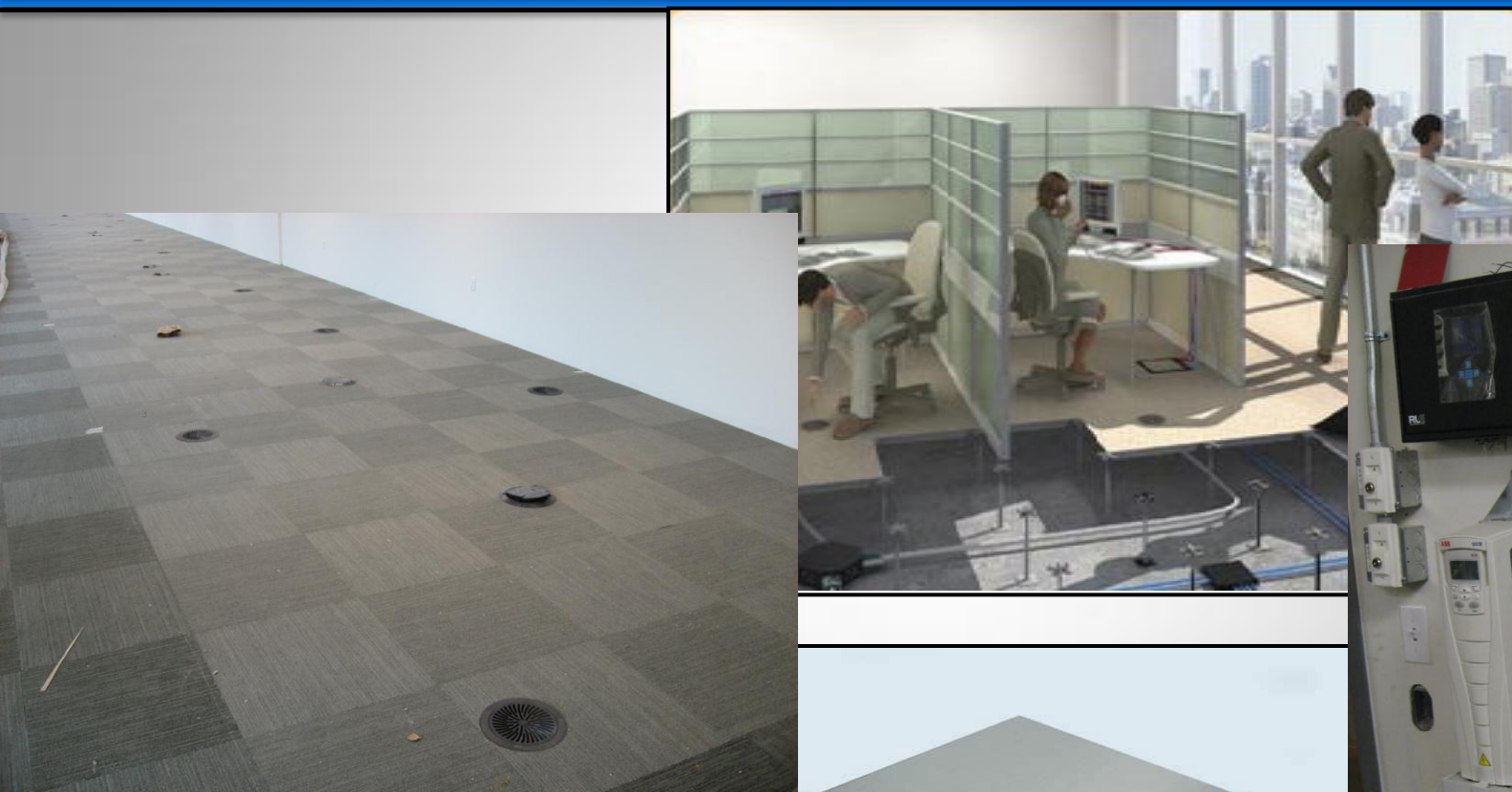


New Town Green Enhancements

- **Total Light Management System:**
 - Manages electric light and daylighting centrally
 - Fluorescent ballasts/digital electric **lighting** controls
 - Digital **shading** systems
 - Monitors systems for the highest energy performance and lowest maintenance cost
 - Saves Energy
 - Lowers operating costs and peak demand charges
 - Improves Comfort and Productivity

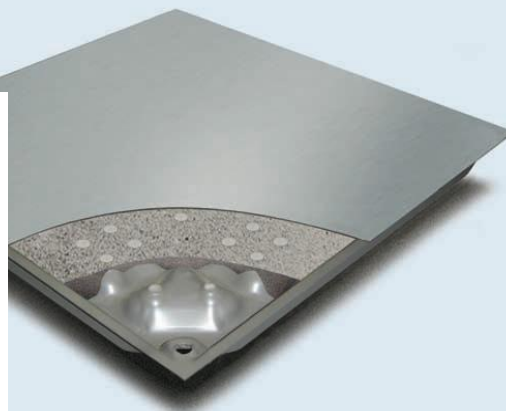


New Town Green Enhancements



☐ Underfloor Air Distribution System

- Reduces Building Materials
- Saves Energy
- Provides Healthier Environment
- Provides Flexibility at Low Cost
- Eliminates Saturation Wiring



New Town Green Enhancements

Workplace Effectiveness

❑ Demountable Walls:

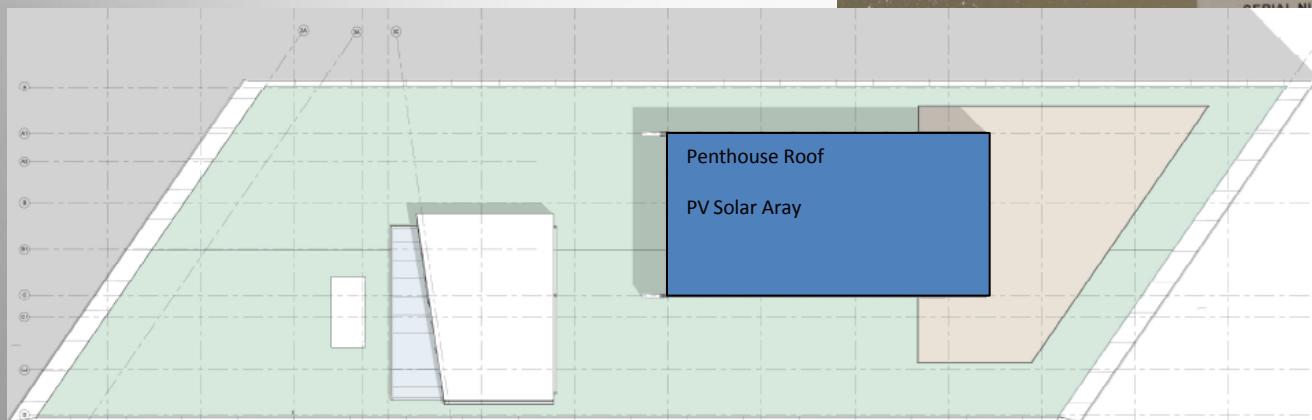
- Provides Great Flexibility
- Used in 3 of 4 Walls in Offices
- Can get all the same materials, colors, sound absorption qualities, and other standards as solid built-up walls



New Town Green Enhancements

☐ Photovoltaic Solar Panels

- Renewable Energy
- PV Array on Penthouse Roof
- Expect 25 KW (2000 SF X 12.5 W/SF)



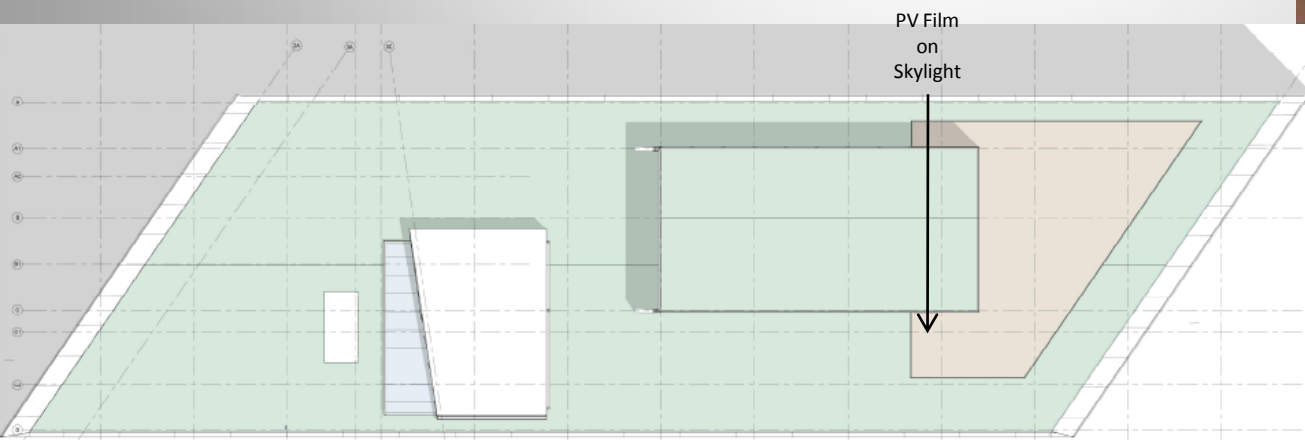
New Town Green Enhancements

☐ Photovoltaic Window Film

- Renewable Energy
- PV Film on Skylight
- Prototype System
- Expected 1.5KW



See Thru used as a Skylight





Green Enhancements to Achieve LEED Gold

- Sustainable Sites
 - Green Roof
 - Water Retention Area
 - Pervious Pavements
- Water Efficiency
 - Drought-tolerant, Native plant
 - High Efficiency Fixtures
- Energy and Atmosphere
 - Building orientation to maximize energy efficiency
 - Geothermal Ground Source Heating/Cooling System
 - Photovoltaic Solar Panels and Window Film
 - Total Light Management System
- Materials & Resources
 - Recycled Construction Debris (~95%)
 - Construction Material Recycled Content
- Indoor Environmental Quality
 - Underfloor Air Distribution System
 - Optimization of Daylighting Strategy

Bottom Line Benefit:
Energy use projected to be less than 1/4 of an average building at Langley



Architectural Use of Historic Artifacts



16-Foot Supersonic
Wind Tunnel
Fan Blades



Partnering with GSA

- Partnered with GSA for New Town Phase I; plan to continue partnership
- Evaluated three options
 - Status Quo – GSA solution
 - In-house solution
 - On-site contractor solution
- Status Quo – GSA solution
 - GSA awards and manages design, CM/QA, construction, and activation contracts
 - Disadvantages: Not developing detailed in-house technical competence; GSA fees
 - Advantages: GSA experience, large support staff/reach back, prequalified contracts, many highly qualified bidders, GSA now familiar with LaRC, GSA fees are low-cost option overall

Phase 2: Integrated Engineering Services Building (IESB)

- 139,000 GSF, two floors
- 130 occupants
- Targeting LEED Gold certification



Services Planned

Engineering Collaboration Center
Strategic Relationships Offices
Langley CTO, Navigation Center
Main & Aux. Conference Rooms
Pearl Young Theater, Training Classrooms
Newsroom/Media Briefing Room
Cafeteria/Food Service, Video Studio/Editing
Education/Public Affairs Offices

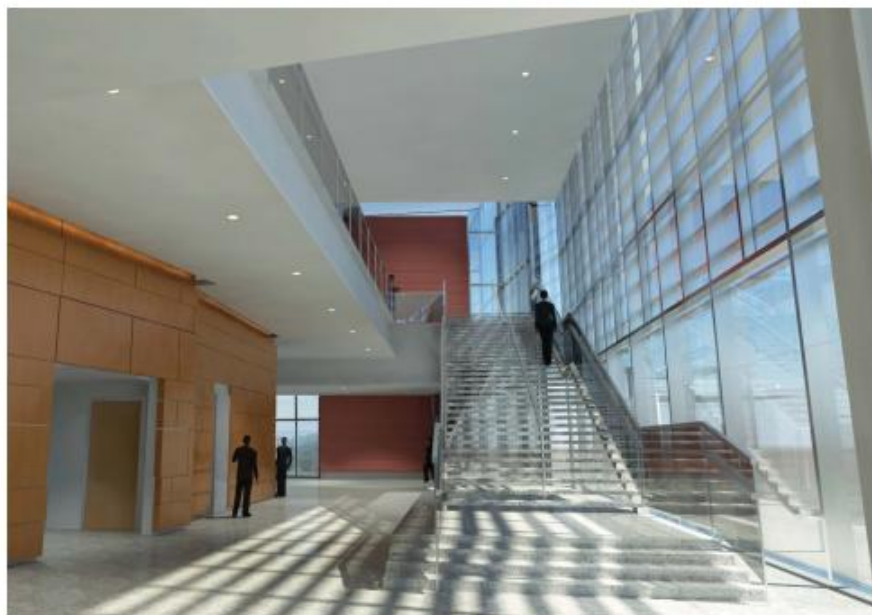


Integrated Engineering Services Building

INTERIOR VIEWS

NASA Langley Research Center Integrated Engineering Services Building (IESB)

A-21



VIEW - WEST LOBBY



PERSPECTIVE - AUDITORIUM



PERSPECTIVE - LARGE CONFERENCE ROOM

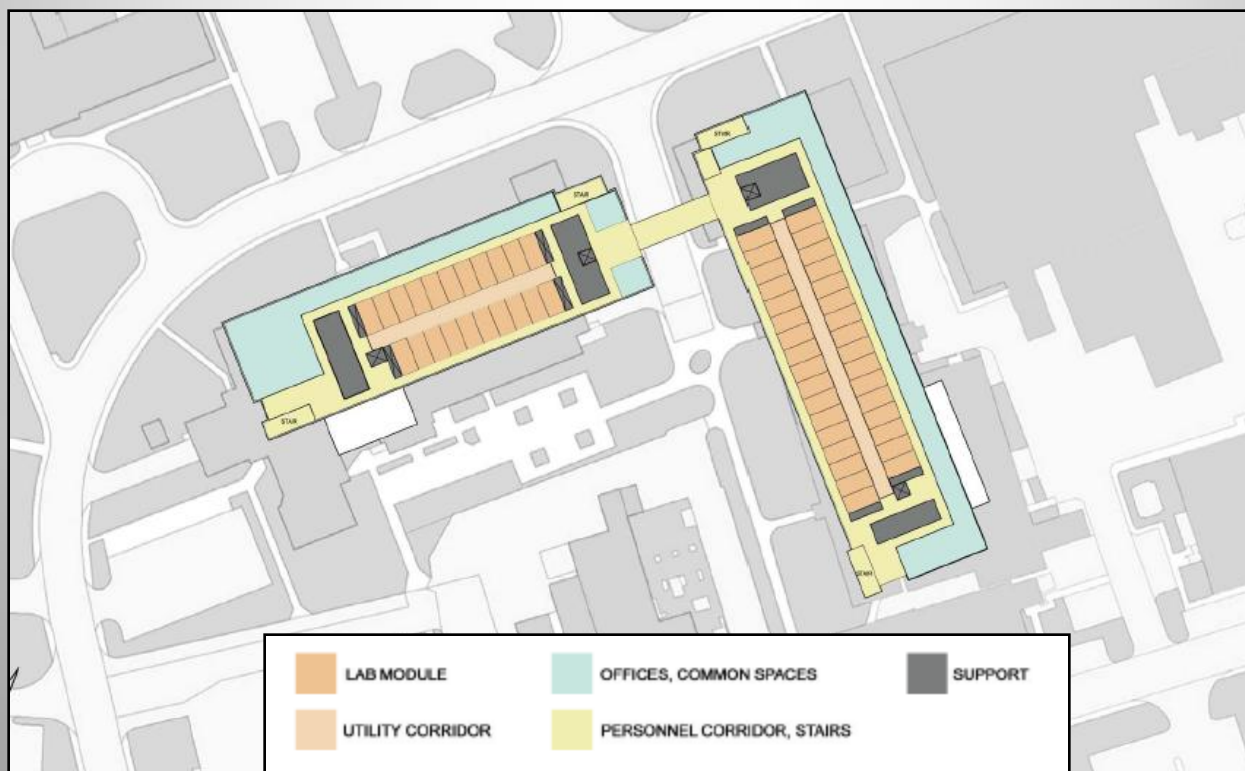


PERSPECTIVE - DINING AREA



Phase 3: Measurement Science Laboratory

- ❑ 150,000 SF – 2-part complex - 3 floors
- ❑ Research and Development Facility for Measurement Sciences in Research and Engineering Directorates
- ❑ 260 Occupants
- ❑ Targeting for LEED Gold Certification

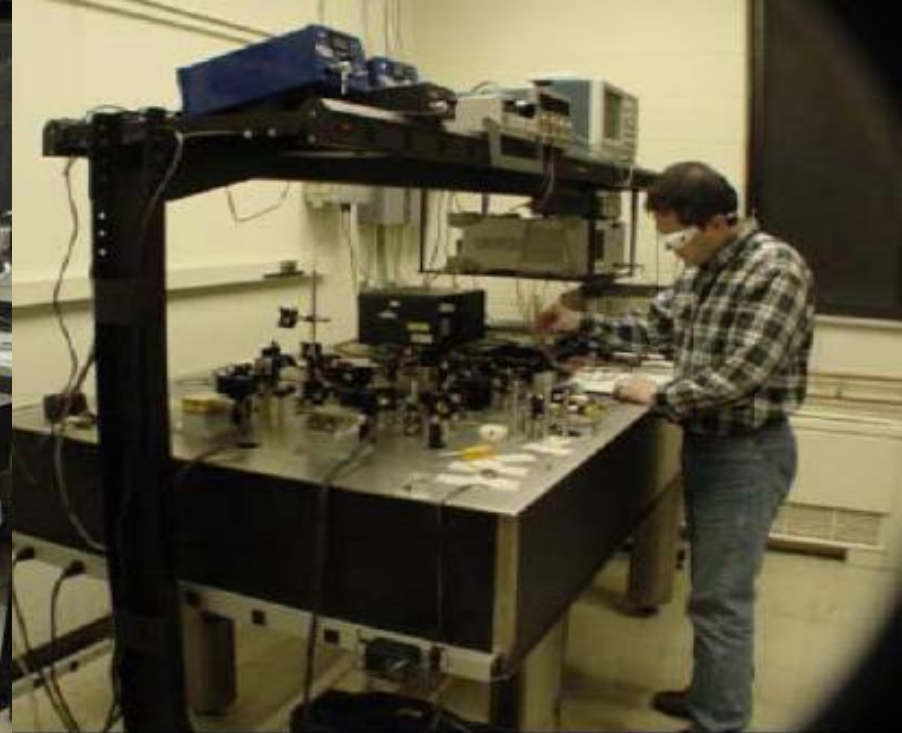




Phase 3: Measurement Science Center Challenges

Phase 3 will resolve many problems identified with the existing sensors, lasers, and optics labs:

- Located in very old facilities (avg. age: > 50 years)
- Not designed for their intended use (retrofitted into offices)
- Experiencing problems with:
 - Excessive temperature variations
 - Excessive building vibrations
 - Excessive dust contamination
- Inflexible and difficult to adapt for future mission requirements
- Undersized with inadequate storage
- Scattered in multiple locations throughout the Center.
- Reliant on inadequate and poorly distributed utility systems







Summary of New Town Benefits

- Reduces **Operations and Maintenance Costs**
- Reduces **Footprint**
- Reduces **Current Replacement Value**
- Strengthens LaRC **Capabilities** in Sensor, Laser, and Material Evaluation Areas
- Attracts **New Business Opportunities** with Modern Facilities
- Improves **Office Efficiency**
- Helps to Attract and Maintain the **Best & Brightest Employees**
- Fosters **Collaboration** Between Various Organizations
- Improves **Flexibility** with Standardized Office Spaces and Reconfigurable Labs
- **Frees Up Land / Facilities** for Other Uses
- Is a Visible Sign of Langley's **Revitalization** and **Sustainability** Efforts
- Increases **Employee Morale**

New Town will provide clear tangible benefits and significant improvements to productivity, morale, and flexibility to adapt to the agency's future needs



Utility and Energy Services Contract (UESC) Project Scope

- Energy Efficient Lighting (82 Buildings)
 - Reduces lighting energy consumption by upgrading with efficient lighting systems while providing quality lights to match the use and physical attributes of the spaces
- Water Conservation (46 Buildings)
 - Reduces water consumption by replacing existing water fixtures, faucets, and dishwasher devices with more efficient fixtures
- Mechanical HVAC Retrofits (11 Buildings)
 - Replaces chillers, air handling units, and pump/fan motors with higher efficiency units. Installs variable speed drives on pumps and fans. Performs retro-commissioning to improve operational efficiency of building's heating and cooling systems
- Photovoltaic Solar Energy System (Badge & Pass Office)
- Light Emitting Diode (LED) Streetlights (Center-wide)
- Winner of HRSD (Sanitation Authority) Pollution Prevention Award



Examples of UESC Energy Conservation Measures



Air Handling Units



Variable Speed Drives



Lighting



Chillers



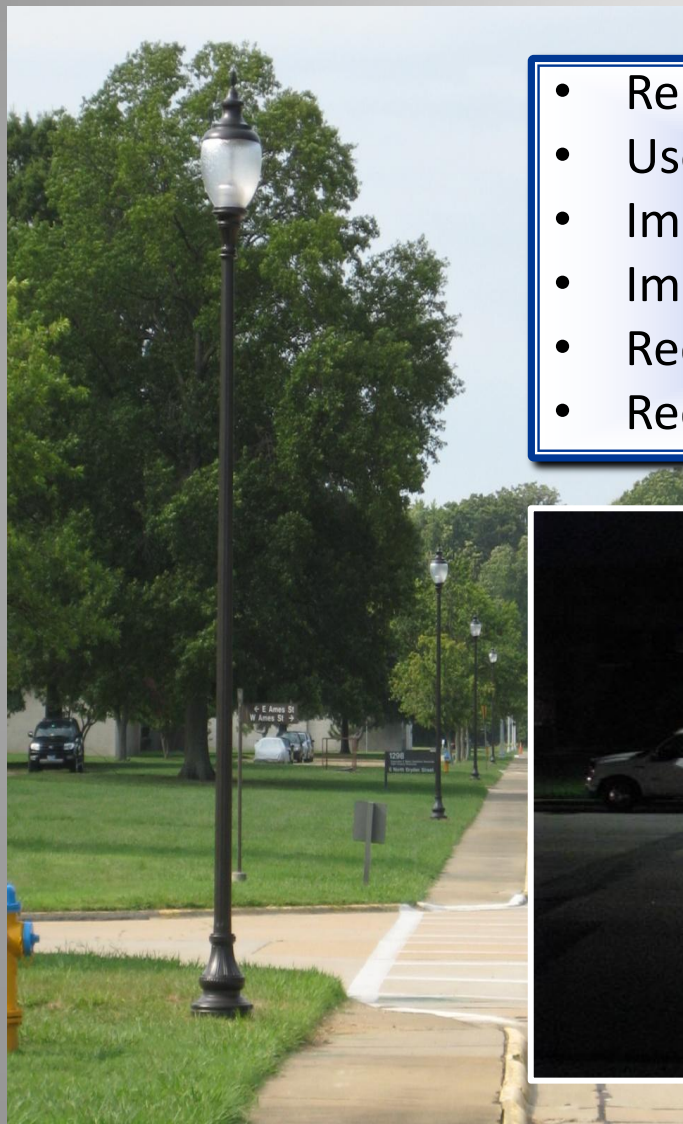
Tower Water Pump Motors



Chilled Water Pump & Motor

UESC LED Street Lights

- Replaces 45-60 yr. old lights
- Uses LED technology
- Improves light quality
- Improves safety & security
- Reduces maintenance costs
- Reduces energy consumption



UESC Photovoltaics



- LaRC's First Photovoltaic (PV) Array
- Renewable energy for ~50% of Building's annual electricity



PV Display



Badge and Pass Office Solar Energy Project

Overview

Current Status

Weather Conditions

This 39.5kW ground-mounted solar energy system will produce around 50,000 kilowatt-hours of electricity each year.

The system consists of 168 photovoltaic modules mounted on two arrays located behind this building. This project demonstrates the performance of solar energy and the benefit of renewable energy being in our overall energy strategy.



<http://sem.kiosk-view.com/nasa>



Energy Today



36
kWh

Total energy generated by the system today

Energy Yesterday



213
kWh

Total energy generated by the system yesterday

Lifetime Energy



577
kWh

Total energy generated by the system since installation

UESC Project Benefits

- **Lighting Retrofits**
 - Electrical energy savings of **8,770,000 kWh annually**
- **LED Street Lights**
 - Electrical energy savings of **23,000 kWh annually**
- **Mechanical Retrofits**
 - Electrical energy savings of **240,000 kWh annually**
- **Steam Use Reduction**
 - Mechanical retrofits reduce steam use by **10,000 Mbtu annually**
- **Water Conservation**
 - Water reduction of **10,930,000 gallons annually**
- **Renewable Energy**
 - Electrical energy savings of **44,000 kWh annually**
- *Total estimated savings **\$968,000** with a simple payback of **9.7 yrs.***
- ***This UESC enables LaRC to expedite compliance with mandated conservation regulations at an aggressive rate.***

Virtualization Benefits

- Server Virtualization: Partition one physical server into several virtual servers
- Benefits:
 - Savings on: Server Hardware, Power and Cooling, Server Storage, Networking, Server Rack Space, and Provisioning Labor
 - Reduced hardware maintenance costs
 - Increased space utilization efficiency in the server rooms
 - Dedicated “virtual server” preventing one application from impacting another when upgraded/changed
 - Standardized server build = easy duplication = fast server deployment/restoration
 - Increased flexibility with multiple operating systems on a single hardware platform
- Cost Benefit Analysis (over 5 Years)
 - Investment \$560K;
 - Total Savings \$620K;
 - Payback 4.5 years
- Environmental Impact Equivalents (over 5 years)
 - 6,300 Trees planted
 - 220 cars off the road
 - 2,800,000 lbs of CO₂ emission avoided

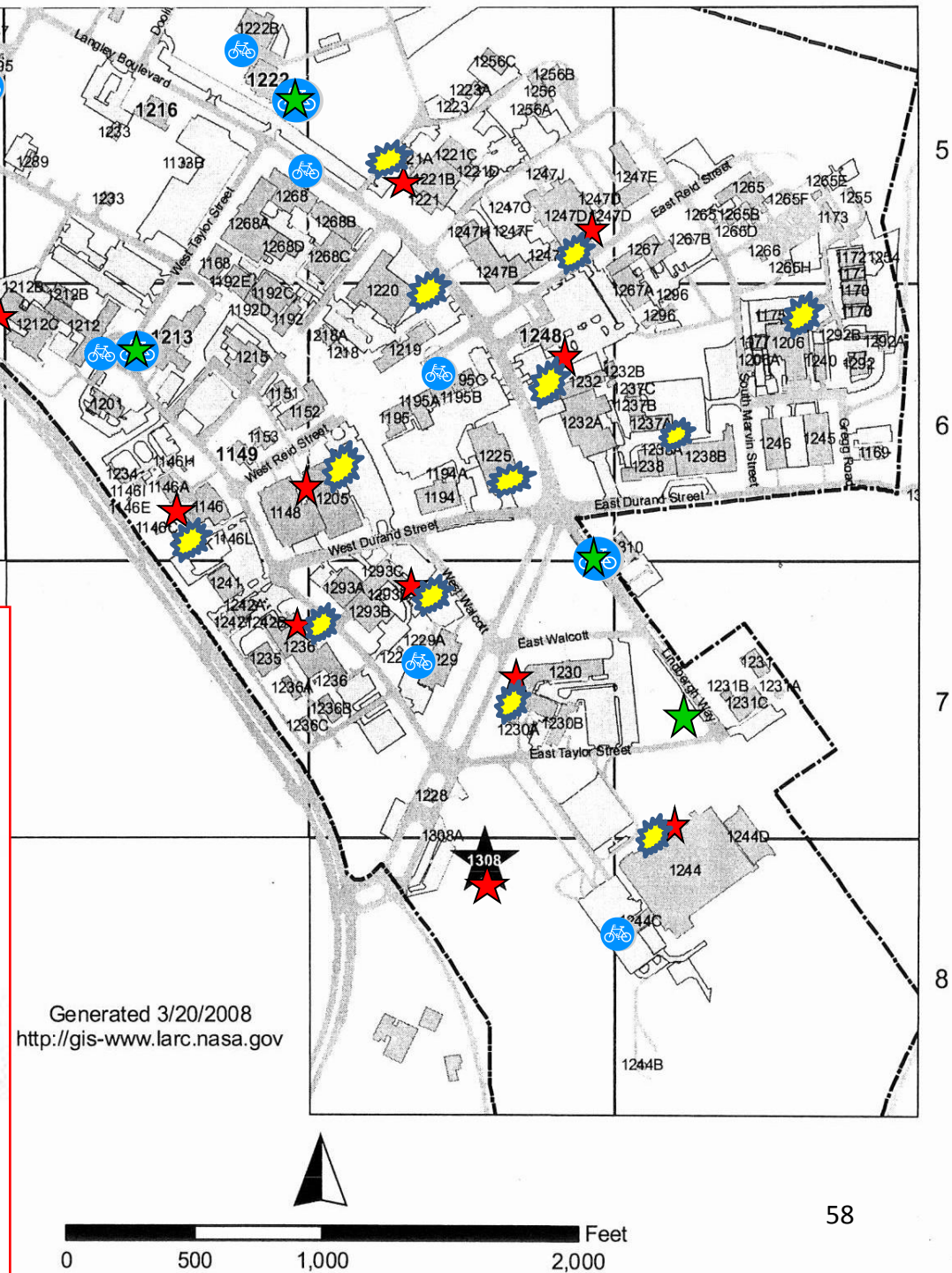


Greening Fleet Operations

- Fleet Reduction
 - 33 vehicles in 2009
 - Current fleet at 103
 - Mostly light-duty trucks
- Fuel-use reduction
 - Current use at ~16,500 gallons
 - Reduced ~17,000 from 2005 to 2010
- Alternative Fuels
 - E85 for Flexfuel fleet vehicles
 - Compressed Natural Gas fleet vehicles
- Re-refined Oil in all but heavy-duty diesel trucks (13)
- Retread Tires for heavy trucks and equipment

Greening Langley: Expanding Bicycle Use

-  Existing bikes
-  Existing racks
-  Current racks in use
-  New racks
-  New bikes



Renewable Steam Generation

RECOUP--A cooperative agreement between Hampton and LaRC to share costs and benefits from the operation of the Refuse-Fired Steam Generating Facility

- Solid waste disposal
- Cheap steam generation

LaRC Steam Demand

- HVAC: Up to 90,000 lb/hr
- Steam Ejectors: Up to an additional 70,000 lb/hr

RECOUP

- Two Boilers; 53,000 lb/hr total export capacity
- Currently operating under 20-year cooperative agreement (2000-2020), LaRC and Hampton
- Historically ~75% of the Center's steam requirements supplied from RECOUP



Langley's Recycling Program



It's not
dumpster
diving, it's
**Aggressive
Recycling**

Divert ~90% of our solid waste from landfills per year
(Agency goal is 50% by 2015)

Also, roughly 93% of our demo waste diverted from landfills in FY10

Langley Recycling Program Results for Calendar Year 2010



67 tons



25 tons



3 tons



4 tons



4 tons

Also:

- 706 tons of scrap metal
- 2,500 toner cartridges



Environmental Restoration Program

- 1991 - Restoration program began with 13 sites
- 1994 - NASA LaRC added to National Priorities List (co-listed with LAFB)
- 1994 to 2006 – Remedial Actions or closeout of 10 sites
- 2010 – Construction Debris Landfill soil remedy implemented





Environmental Restoration Program

- 2011 – Construction Debris Landfill groundwater treatment
- 2012 – Site 15 & Stratton closeout
- 2013 - Begin NPL de-listing process
- 2015 - EPA approval to de-list NASA LaRC
- Long Term Monitoring of sites



Construction Debris Landfill 2010



Other Sustainability Considerations



- Funding realities are a real threat to reasonable recapitalization approaches. Forcing tough decisions on critical resources.
- Emotional reactions can enhance or inhibit sustainability initiatives
 - Resistance to demo of “revered landmarks”
 - Reluctance to give up technical capabilities or facilities because of what is “possible”
 - Going green is great, unless it results in personal inconvenience – culture change
- Sustainability is more than a set of technical solutions. It is an integral part of a comprehensive facility strategic process and embedded within organizations (EMS, Energy teams, etc.).
 - “Sustainability concepts and thinking are inherent in NASA’s mission, strategic goals, and overarching strategies.” – 2011 SSPP
- We MUST continue to develop and enhance at least SOME capabilities to remain relevant in the future. Shrink wisely; purposefully invest limited resources

LaRC Facility Strategic Planning Roadmap

Mission / Guidance

NASA Mission

Current Mission...

Early-Stage Innovation

Game Changing Tech.

Crosscutting Capability Demonstrations

National Policies

LaRC Mission

Exploration: STEP

Aeronautics: New projects

Science: New/accelerated

Shape our Customers/ Stakeholders Vision and Make It Real

Drive Innovation to System Solutions

Operate at the Pace of Innovation

Embed Innovation in Our DNA

LaRC Core

Aerosciences

Structures and Materials

Systems Analysis

Charact. of Atmospheres

Entry, Descent, and Landing

LaRC Initiatives

Create the LaRC of the Future

- 10 Revolutionary Tech Challenges
- 9 SOTs, 21 MOTs, 10 IOTs
- Creativity and Innovation Plan
- 21st Century Lab

Lab / Facility Integration Team

Large / Small Facility Strategy

Future Facilities Teams

New Town / Special Projects

Maintenance Best Practices

Team RISI

ViTAL Team

NASA Guidance

Institutional Readiness Project

"Facilities Program Board"

- Slow-and-Steady, Smaller-Similar
- Reduce Footprint, reduce CRV

Agency Master Planning

- Great plans, solid process, compellingly conveyed
- ALL asset types
- Implementation w/in guidance
- Include workforce projections

Sustainability

Creativity and Innovation

Other Agency Policies

Fed, State, Local, etc.

National Facilities Study

Environmental/Climate Change

Cultural Resources

Energy Reduction

Safety

External Audits

Master Plan

- Exploration – direction / needs
- Validation – current assessment
- Hypothesis/Testing – alternatives
- Primary Development Concept
- Development Strategy – Timelines
- S/MA Planning – Risks / Mitigation

Where We Are Going

- Repair by Replacement (NT)
- Consolidate within core
- Sustainable
- Efficient
- Flexible
- State of the Art

How We Get There

- Right projects at the right time
- Matching projects with funding

What We Have

- Processes
- Databases
- Maps
- Utilization

Projects

Potential Projects

Project Prioritization

HVAC, Repair, Roofs, ADA, etc.)

Safety, Life Safety, Security, etc.

Lab Consolidation, Demolition

Energy / Environmental

Programs / Center funded

Program-direct, Institutional

Sustainment, Renewal, Transition

Program Formulation

CIPP (20-year plan)

Recapitalization

New Town Follow-on (3 phases)

New Town (5 phases)

CoF (5-year plan)

Enviro. Comp. and Rest.

Strategic Investment

Center Investment

Maintenance (CM&O, Programs)

Master Project List

Infrastructure

Wind Tunnels

- Subsonic
- Transonic
- Supersonic
- Hypersonic

Laboratories

- Materials
- Structures
- Measurement
- Laser / Lidar
- Acoustics
- Aerodynamics
- Hypersonics
- Flight Dyn./Controls
- Crew Sys./Avia. Ops
- Electronics and Avionics Systems
- Sys. Dev, Fab, and Integration
- Environmental Test

Simulators/ Aircraft

- Aircraft
- CMF
- VMS
- DMS
- Hangar
- Flight Ops Support Cntr

Other

- LN2 Plant
- Fab Facilities
- Clean Rooms
- Digital Library
- etc.

Horizontal Infrastructure

- Electrical
- Steam
- Water
- Sewer
- Roads
- HP Air
- [IT]

Real Estate

- Developed
- Green space
- Wetlands
- ?

Office Space

Master Facilities List

On Demand Air Mobility...

Space is Open to Everyone...

Climate Change Concerns are Resolved...

We are NASA's Innovation Engine!

NASA Langley Research Center Organization

Environmental Management Committee includes representatives from various organizations (in green)

Environmental Management Sponsor at senior level



EMB is under Center Operations Directorate



What's Next?

- Refining overall facility strategy process – beginning to focus on implementation details, with an eye toward pervasive sustainability
- Vibrant Transformation to Advance Langley (ViTAL) team – Initiated in March 2011
 - Develop and communicate an integrated facilities and lab strategy
 - Evaluate future capability needs and help manage removal of infrastructure
- Climate Change Adaptation workshop – September 2011
 - Adaptation / Mitigation
 - Risks to LaRC: Hurricanes, Floods, Heat Stress, Disease Vectors, Energy demand
- Re-commissioning of Existing Buildings – studies currently underway
- BIM / O&M – studies currently underway
- Geothermal Retrofit for Existing Building in New Town Core
- Solar Water Heaters
- “North 40” Photovoltaic System
- Utilities and Energy Services Contract Phase 2
- Steam to electricity at RECOUP
- Long-term assessment of Green Roof performance (GSA, GISS, CASI, Universities, HQ)
- Reuse of Greywater
- Experimental biochar-based stormwater filtration (biochar from dead tree branches)

Summary

Langley's sustainability strategy:

- Provides critical basis for infrastructure program/project formulation and prioritization
- Meets the National and Agency goals and metrics
- Leads to facilities that:
 - Support a balanced portfolio
 - Are flexible and appropriate
 - Have increase reliability and work space quality
 - Foster productivity and collaboration
- Ensures that the Langley of the future continues to be ready to serve the Agency and the Nation in the face of evolving missions and requirements
- Strengthens the vitality and livability of the communities that surround NASA Langley